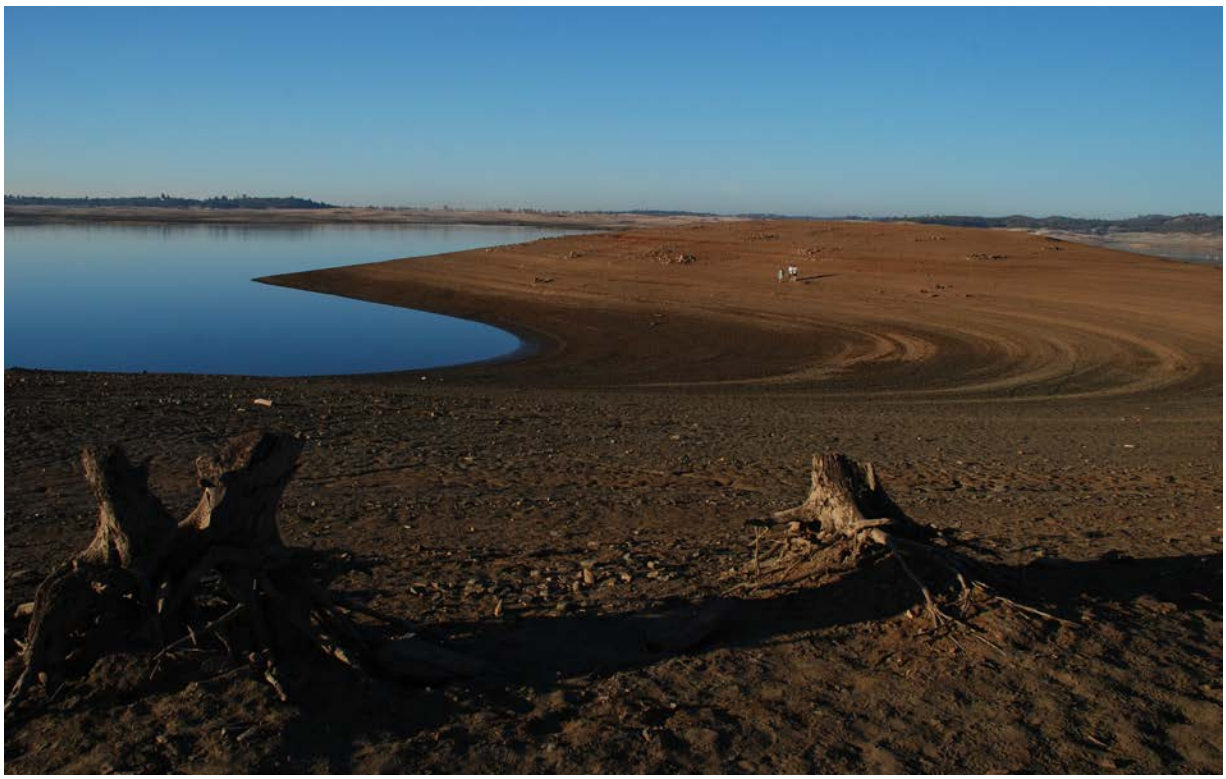
Blue-Green Intersections: Impacts of Water Shortages on Western State Energy Policies



Kristen Nye Larson

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EXECUTIVE SUMMARY

California and Arizona, two of the nation's leaders in renewable energy growth, are also among the states most severely impacted by severe water shortages. In California, where aggressive targets for energy generation from renewable sources characterize state energy plans, hydropower, a major source of green power, has declined by 60 percent of the past three years of drought conditions.

This report analyzes the interdependencies of energy and water policies in Western states confronted with drought conditions. It considers the impact of these conditions on present renewable energy plans, including renewable energy portfolio requirements, in the context of important water and energy consumption trends, as well as other factors, including:

- Relative water consumption by energy producers, particularly electric power plants.
- Local initiatives to address energy generation and water consumption.
- Policy questions surrounding water supply measurements.

Details follow.

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KRISTEN NYE LARSON

INTRODUCTION

Extended, acute water shortages facing Western states have impacted their policy and regulatory landscapes disparately. California and Arizona, two leading states when it comes to accelerating renewable energy generation, face a range of long- and short-term decisions which will determine the extent of their water supply issues on energy plans.

In the region's changing energy sector, traditional power plants are no longer the only option for powering utilities. Alternatives to traditional energy sources projected for the largest gains in market share in coming decades are pushed by state and federal resources and mandates. Solar and wind energy are becoming more commonplace.

It is not a mere coincidence that this part of the United States has also been struggling with water shortages for years. California and Arizona are two Western states that rely on the Colorado River for their water supplies and have been heavily impacted by low water counts. California is now in its fourth year of increasingly severe drought conditions. Arizona, after riding the edge of a drought for several years, has more recently benefited from a welcome, wet spring in the Colorado basin. Water continues to be heavily consumed by older, traditional water-thirsty power plants and high-water demanding crops in the agricultural industry. Both states continue to work towards water conservation for residents, farmers and utilities.

Solar and wind each require little or no water to operate. Both California and Arizona have been among the states with the largest gains in solar market share over the past five years, with California also in this category for its growing wind sector.[1] However, progress is slow and these renewable energy sources are not without their own challenges. This paper will examine water shortages, related policies and how renewable energy options factor into these issues.

[1] Analysis of U.S. Department of Energy data at http://www.energytrends.org/energy-trends-heat-maps/

Electric power plants are a major water consumer

There are many obvious ways to observe water consumption: a resident watering their grass, a farmer tending to his fields, a business running a fountain. There are also some not-so-obvious major water consumers, one of which is our nation's electric power plants.

According to the 2011 report by the Union of Concerned Scientists, power plants across the country in 2005 withdrew as much water as farms did. Thermoelectric power plants have been the largest water users in the United States since 1965.*

Electric power plants use a combination of fresh or surface water and salt water to power the systems. The U.S. Geological Survey estimated electric power plants used 201 billion gallons a day in 2005, accounting for 49 percent of total water use, 41 percent of total freshwater withdrawals, and 53 percent of fresh surface-water withdrawals for all categories of use.**

Why do power plants use so much water? Electric power plants are run by thermoelectricity. The plants use fresh or salt water that is boiled and turned into steam to power the turbines. After that, more water is used to reduce the temperature of the steam so it turns back into water to produce more electricity. The majority of water used in these power plants is used during this steam cooling process.

There are different types of electric power plants, each varying in its water consumption and environmental impact. The most severe impacts come from the once-through cooling system model. Such a facility withdraws the water directly from the lake, river or ocean, and removes any salt from the water. After the water is used in the power plant's process, it is then re-deposited back into the originating source. Because the re-deposited water is often a different, warmer temperature, aquatic ecosystems are upset, often resulting in the death of fish and other native plants and organisms. Regulations now restrict this type of system in any new power plant.

Other, less invasive systems use cooling towers and other machinery to contain the water instead of dumping warmer water back into respective reservoirs. Some, more efficient systems also utilize treated wastewater for cooling. In Arizona, the Palo Verde nuclear plant uses reclaimed water for its closed-cycle cooling, and has decreased its potential freshwater use by 55 million gallons per day.

Further worsening of water supplies in the West will likely mean stakeholders need to explore not only alternative methods of energy, but also electric power plant systems that minimize impact on fresh water supplies.

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*Union of Concerned Scientists, *Freshwater Use by U.S. Power Plants: Electricity's Thirst for a Precious Resource*, November 2011.

**Kenny, J.F., N.L. Barber, S.S.Hutson, K.S. Linsey, J.K.Lovelace, and M.A. Maupin. 2009. Estimated use of water in the United States in 2005. U.S. Geological Survey Circular 1344. http://pubs.usgs.gov/circ/1344/pdf/c1344.pdf

IMPACTS OF WATER ON ENERGY

Certainly, drought conditions in California are the most severe. Snowpack provides about one-third of the water used in California and the state has been heavily impacted by the declining snowpack over the last four years in the Central Valley and Sierra Nevada mountains. Recent Sierra Nevada snowpack measurements are the lowest on record since 1950. Now in its fourth year of a drought, California is experiencing new statewide water mandates and restrictions as a result of the shortage.[2]

While Arizona is dealing with the same water shortages that have impacted California, it has yet to enact statewide water conservation mandates. Water experts in Arizona say that the state has been preparing and stockpiling water for years in anticipation of future droughts.[3]

Data show that California and Arizona consumers are relying less on traditional energy sources, as wind and solar power increases in use and popularity. What impacts can be expected from such shifts in energy use patterns on current and future water shortages? Some of the initiatives and subsequent policies and incentives have been part of larger energy conservation initiatives, and may have inadvertently helped reduce effects of the recent, extreme drought conditions.

One of the most significant drought impacts to states' energy systems is on traditional hydropower systems. Throughout California, hydroelectric production has declined 60 percent over the last three years. Historically, the state had been the third-largest producer of hydroelectric power nationally.

Most of its large hydroelectric plants are located in Northern California. Power production at the Hoover Dam, which straddles the Arizona-Nevada border, has dropped by 25 percent over the last 15 years, directly related to a slower and lower water flow in Lake Mead. California is home to nearly 300 hydroelectric systems, and has seen a 60 percent drop in energy production over the last 4 years.[4]

One way this has impacted consumers is by increasing energy prices, most observable in local markets. A 2015 Pacific Institute report calculated the loss of hydropower in California from 2012 to 2014, from an average of 18 percent of the state's power supply to 12 percent, or 34,000 gigawatts (GW), costing consumers $1.4 billion. The increase in cost

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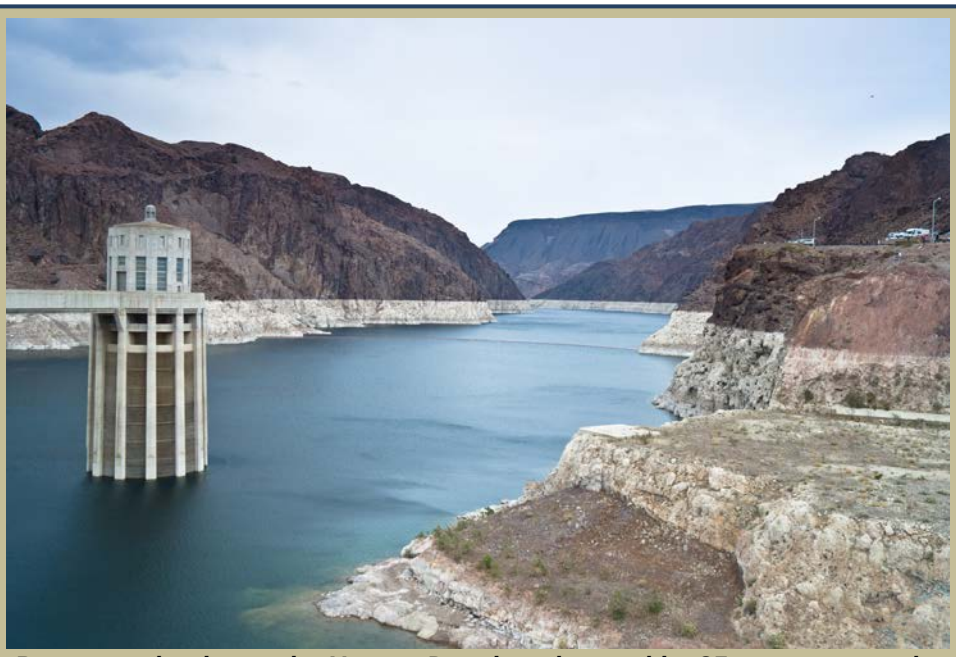
[2] Ana Swanson, 8 fascinating images explain California's dangerous drought, *The Washington Post*, April 17, 2015.
[3] Justin Pazera, California deals with severe water shortage while Arizona stockpiles supply, ABC 15 Arizona, April 3, 2015.
[4] Todd Frankel, Western drought steals clean energy along with fresh water at power plants, *The Washington Post*, April 26, 2015.

can be attributed to replacing the less expensive hydropower with more expensive, and more polluting, natural gas.[5]

California's largest power utility, PG&E, has charged its consumers a 1.5 percent rate increase to compensate for costly hydroelectric power due to water shortages. In Roseville, California, the utility imposed a 2 percent "hydroelectric surcharge" on ratepayers. With these shortages and rate increases have come incredible growth in wind and solar energy, with solar power tripling in 2014.[6]



Power production at the Hoover Dam has dropped by 25 percent over the last 15 years, directly related to the water level in Lake Mead.

STATE RENEWABLE ENERGY PORTFOLIO PLANS

State laws to aggressively increase the share of energy generated from renewable sources, called renewable portfolio standards, are often regarded as the centerpiece for overall strategies for carbon emission reductions and addressing climate change. But the impacts of these plans on drought conditions and future water use requirements have not been central to their design. Understanding implications of renewable energy plans on water use will be essential in states most severely impacted by drought.

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[5] Peter H. Gleick, Impacts of California's ongoing drought: Hydroelectricity generation, The Pacific Institute, March 2015.

[6] Dale Kasler, California's hydro power dries up as drought worsens; utility customers paying more, *The Sacramento Bee*, March 27, 2015.

California's Renewable Portfolio Standard (RPS) originally required utilities to generate 20 percent of their electricity from renewable sources by 2010. The California state legislature and Governor Jerry Brown worked together to pass legislation in 2011 to require California utilities to get one-third of their electrical power from renewable sources, giving the state the most aggressive alternative energy mandate in the entire United States. The utilities and other electricity providers have until the end of 2020 to meet this 33 percent renewable energy goal.[7]

In 2006, California lawmakers passed Senate Bill 1368 to limit coal-fired energy. As a result of this legislation, California limited new coal-fired power plants to an output of 1,100 lbs of CO_2 per megawatt hour (MWh).

Arizona created its Renewable Energy Standard and Tariff in 2006, a mandate that requires utilities to procure 15 percent of their electricity from renewable sources by 2025. The law says that utilities will gradually increase their supply of renewable sources by approximately 1 percent per year up to 15 percent by 2025. The utilities recently announced that they had met their goal for this year of 6 percent of renewable energy use,[8] much of which can be attributed to solar energy.

Despite this recent progress, over the last decade, the state renewable requirements have been subject to criticisms and changes in incentives that have had the potential to impact progress. In February 2013, the Arizona Corporation Commission cut its renewable energy incentive programs. Commercial production-based incentives were eliminated entirely and residential incentives were reduced substantially. The Commission stated that the incentives helped launch programs for the state, but that it was not fiscally wise to continue to subsidize the initiative with taxpayer dollars. Solar costs had dropped and the Commission didn't feel that the change in incentive offerings would slow down the state's renewable energy progress.[9]

In late 2014, the Corporation Commission unsuccessfully lobbied state lawmakers for changes made to the current goal. The Commission said that long-term energy goals are ineffective and lawmakers should instead look at short 3-year goals that are routinely evaluated and changed. To date, the goal of 15 percent of renewable energy sources by 2025 remains in place.

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[7] Adam Weintraub, California to require utilities to get a third of power from renewable sources, Associated Press, April 13, 2011.
[8] Staff report, "Several Arizona utilities poised to meet renewable energy goals by 2016," Associated Press, August 3, 2015.
[9] Bob Stump, Brenda Burns, Bob Burns, Gary Piece and Susan Bitter, Solar power must flourish in Arizona, but not at taxpayers' expense, *Arizona Daily Star*, February 12, 2013.

WATER CONSERVATION CHALLENGES

Unfortunately, one of the biggest challenges of drought management and response is that most states do not have realistic assessments of water supplies and future projections. Experts have questioned the accuracy of California and Arizona water supply reports. Arizona is slightly ahead of California in terms of incorporating measures of its groundwater supply, and often restricts how much water can be pumped from it. However, comparable water supply measures are undermined when discrepancies between overlapping supplies of groundwater and surface water are not addressed consistently. Acknowledging and connecting the relationship of water supply sources is an important factor in accurate accounting of water supply.

"States have their own take on this. Or they choose to not address it at all," said Stanley A. Leake, a hydrologist with the U.S. Geological Survey who is a leading expert on properly accounting for the connection between ground and surface waters in the West, in a recent *New York Times* article. "In some cases they pretend that there is no connection."[10]

A report released by the U.S. Department of Energy in 2014, "The Water-Energy Nexus: Challenge and Opportunities," sheds light on traditional energy sources and their interdependencies with water supplies. Both recent drought conditions in the West and the havoc wrought by Hurricane Sandy on the East Coast in 2012 placed the resiliency and sustainability of water and energy systems under new scrutiny. The report also noted that the agricultural industry, as the largest national consumer of water, must be an integral part of discussions about the viability of solutions.[11]

"The current water-energy decision-making landscape is complex and fragmented," observed the 2014 report. "The nation's water and energy policies have been developed independently from one another, and in many cases there are strong regional differences in policy frameworks and objectives."[12]

The report calls for national collaboration, with the federal agency serving as a clearinghouse on data collection and the sharing of best practices for water conservation and energy options. The Department of Energy acknowledges the challenges in collecting needed data and the technical infrastructure to store and redistribute the information. It is also important to note the differences in regional plans and needs based on local water supplies, population and energy sources. [13]

[10] Abrahm Lustgarten, How the West overcounts its water supplies, *The New York Times*, July 17, 2015.
[11] U.S. Department of Energy, The water-energy nexus: challenge and opportunities, June 2014.
[12] *Ibid.*
[13] *Ibid.*

AGRICULTURE'S HEAVY WATER RELIANCE

Because 80 percent of California's water consumption is for agricultural purposes,[14] the success of water-efficiency initiatives will depend heavily on how they are addressed by the sector. On April 1, 2015, Governor Brown imposed the first-ever state executive order restricting water use.[15]

The order coincided with the promotion of the state's Home Energy Renovation Opportunity (HERO) program. HERO helps connect homeowners with energy efficient products and vendors. The program also provides consumers with financing options through property taxes.[16] HERO was supported by many California localities and used as a tool to help consumers conserve energy. State officials reported that for the month of June 2015, Californians conserved water, reducing use by 27.3 percent and exceeding the governor's 25 percent mandate.[17]

Since the executive order, water conservation initiatives have continued to expand. In June 2015, California state officials moved forward with plans to tighten farmers' water rights that were originally implemented in 1903 and had not been changed or touched since 1977. Specific areas, including more than 100 water right holders in the San Joaquin and Sacramento watersheds were instructed to cut water use by as much as 36 percent. In other areas of the state, farmers have worked with state officials to implement voluntary self-imposed water restrictions. As predicted, reaction to the measure has been highly controversial, with both sides pursuing litigation that will ultimately require court-determined closure to the issue. [18]

California and other drought-affected states are also heavily impacted by federal farming incentives, which often undermine state water-efficiency initiatives. For example, cotton demands one of the highest levels of water supply to grow (six times what lettuce needs) but it offers high federal incentives. Getting farmers to voluntarily change crops and use less water when it impacts their financial gain is a continuous challenge.

Agricultural policies figure prominently in Arizona's efforts to reduce water use. In early July 2015, Lake Mead dropped to its lowest point since it was created by the construction of the Hoover Dam.

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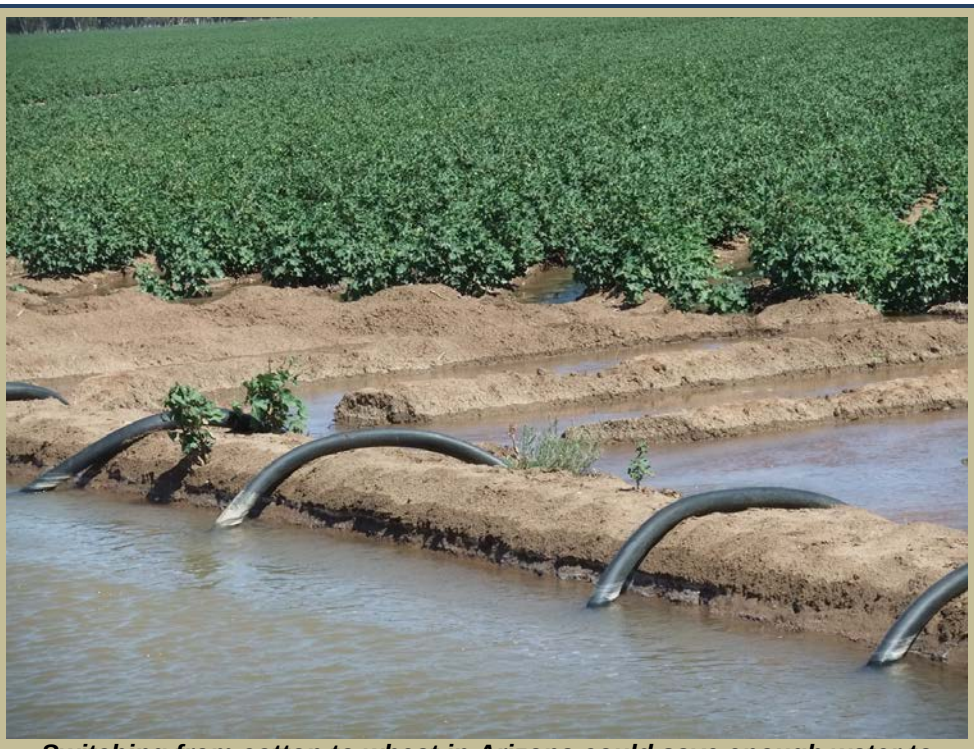
[14] Ana Swanson.
[15] Governor Jerry Brown, Executive Order B-29-15, April 1, 2015.
[16] Dawn Killough, Program offers water saving help for drought-stricken Californians, Green Building Elements.com, April 6, 2015.
[17] George Kostyrko, California water use drops 27.3 percent, exceeds 25 percent mandate for June, Ca.gov website, July 30, 2015.
[18] Jennifer Medina, California cuts farmers' share of scant water, *The New York Times*, June 12, 2015.

In a recent series for ProPublica.org, Abrahm Lustgarten looked closely at the West's reliance on the Colorado River and potential opportunities to return water supplies to prior levels. Lustgarten argued that if Arizona farmers switched from growing cotton to growing wheat, it would save enough water to supply about 1.4 million people each year. Arizona struggles with more severe drought conditions than any other state that utilizes water supply from the Colorado River.[19]



Switching from cotton to wheat in Arizona could save enough water to supply 1.4 million people each year.

But meeting the energy needs of its various sectors also holds strong implications for water use. Northern Arizona is home to the 50-year-old Navajo Generating Station, which is the nation's third largest emitter of carbon dioxide and climate warming gases, of any power facility in the country. The area surrounding the Station is covered by air pollution and haze. The enormous power station helps move water from supply areas to water-deprived areas of Arizona, carrying the water up an elevation of 3,000 feet and across more than 300 miles in distance through the cities of Phoenix and Tucson. It consumes about 22,000 tons of coal each day and provides cities that were historically viewed as inhabitable, the means to sustain its population.[20]

[19] Dave Davies, How a historical blunder helped create the water crisis in the west, National Public Radio/Fresh Air, June 25, 2015.
[20] *Ibid.*

On a micro-level, officials in Tucson have offered consumer rebates and incentives for residents who use xeriscaping, water-efficient appliances, and rainwater and gray water harvesting. Gray water harvesting is using reclaimed water for outside green spaces. Residences are also eligible to receive incentives for installing rainwater-harvesting systems.[21]

WATER-SMART ENERGY SOLUTIONS

While water use and energy use are interconnected in often-complex ways, some promising solutions being pursued locally have a place in future policy conversations.

Hydropower

While the implications of present drought conditions on hydropower for electricity generation embody these complexities, hydropower has been utilized, including on a small residential scale, for many years. Now some power utilities are considering ways to leverage existing water pipe infrastructure to create mini hydropower generators. This initiative was explored in June 2015 at the American Water Works Association annual conference in Anaheim, California by NLine Energy, a company which helps utilities implement these mini-hydro units. The units, which have a relatively low start-up cost, use existing pipes and waste water to create energy. This program has been used by some to create a new revenue stream for the utility.

This idea is also being used in the private sector where companies are aiming to reduce their carbon footprint and find efficiencies. Apple is working with Natel Energy on the Monroe Hydro project in central Oregon. Natel Energy is using the company's existing 60-year-old irrigation canal to create a mini hydropower generator that will help power a data center.

The more commercial use of these systems requires larger start-up equipment, resources and planning. In some cases permitting and other logistical details can be a barrier. Advocates for this type of innovation should work with local and state officials to educate them on the benefits of this type of renewable energy.

[21] Holly Heinrich, How 10 western cities are dealing with water scarcity and drought, National Public Radio/State Impact, August 2, 2013.

Solar Energy

When rainfall declines and drought conditions become chronic, stakeholders look at other energy sources to fill the gaps. In those parts of California with the greatest sunlight access, solar power has helped close the energy gap when hydroelectricity supplies drop. California's Energy Commission said the state added more than 1,000 megawatts of solar in 2013, while the state was suffering through drought conditions.[22]

Solar energy has the lowest demand and stress on the water supply, which makes it an easy go-to alternative source of energy during chronic droughts. However, investors and supporters of solar also need to consider the benefits of this energy source along with its cradle-to-grave life cycle assessment. The full-circle assessment examines the environmental impact of materials needed to create the solar panel, the actual life-cycle and the disposal impact of the materials once its usefulness has expired. The average life cycle for solar panels is about 25 years.

Solar energy has the lowest demand and stress on the water supply.

Disposing of panels after their life cycle has ended is a challenge for the solar industry. In 2013 the Associated Press investigated the number of solar manufacturers that were reporting its waste and discovered that it was less than half. The solar industry is expanding very quickly, especially in sunshine-friendly states like Arizona and California, where investors can benefit from high demand and state and federal incentives. All of

[22] Dana Hull, Drought threatens California's hydroelectricity supply, but solar makes up the gap, *San Jose Mercury News*, February 11, 2014.

these investors and stakeholders need to track waste and responsibly dispose of it if the industry wants a truly carbon-neutral option.[23]

Some recent attention to silicon-based solar panels could represent a solution. A 2015 paper, published in the journal *Energy & Environmental Science*, suggests that solar panels made with perovskites instead of the more common silicon, could have a reduced life cycle impact. Perovskite panels can take approximately two to three months of energy to produce, while a silicon panel typically needs about two years to return the energy investment in this way. The study recommends that solar industry stakeholders continue to explore this as a viable option.[24]

U.S. Representative Paul Gosar sponsored a bill in 2014 that would allow Arizona to lease federal land for renewable energy development. Royalties and subsequent energy sales would be split among state, federal, and local governments and conservation efforts. It was said Arizona could become the "solar capital of the world" if allowed to use the public land. Currently the state is third in the United States for solar installations.

Wind

Wind turbines are another renewable energy source that require minimal water use to produce energy. In April 2015, the same month that Governor Brown imposed an executive order to restrict water use, wind generation in the state was up, providing 3,955 GW through the end of April. Overall, California wind generation has grown more than 150 percent from the 1,550 GW California produced during those same months in 2009.[25]

Supporters of wind power assert that while wind energy seems like an easy option for expansion and implementation, investors are limited by access to nearly 3 million acres of federal land that contain the most commercially promising wind resource. Expansion of this source of energy needs to go along with changes to the proposed Desert Renewable Energy Conservation Plan that does not allow access to this desert wind-friendly land. This draft plan has taken six years to pull together and includes many conservation measures that industry says would block any significant wind farms in this prime area.[26]

In Arizona, a high-profile and high-producing wind farm was approved for federal land in 2013. The Mohave County Wind Farm is located on federal land located 40 miles northwest of Kingman, Arizona. Upon completion, the 200-plus turbine wind farm will

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[23] Jason Deardon, Solar panel makers continue to ship tons of toxic waste thousands of miles away, Associated Press/Business Insider, February 10, 2013.
[24] Flordian Rosado, Perovskite- Rapid energy payback shown from solar technology, ReliaWire, July 21, 2015.
[25] Michael Goggin, Wind & solar power conserving water & keeping the lights on in record drought, CleanTechnica, June 29, 2014.
[26] Sammy Roth, Desert renewable energy conservation plan could limit Coachella Valley wind development, *The Desert Sun* (Palm Springs, CA), March 21, 2015.

provide enough electricity to the grid to power up to 175,000 houses. This project is still in development and has recently changed ownership.[27]

Another interesting model of a locally-driven approach to addressing renewable energy and water policy together can be found in Georgetown, Texas, a town just north of Austin. In early 2015, the town moved forward with its own goal of 100 percent renewable energy sources by 2017 and awarded several contracts for solar and wind energy sources. Georgetown Mayor Dale Ross said in a recent op-ed in *Time Magazine* that water shortages and drought conditions influenced the locality's decision to turn to renewable energy. "Traditional power plants making steam from burning fossil fuels can use large amounts of water each day. Our move to renewable power is a significant reduction in our total water use in Georgetown," Ross said.[28]

Wind generated power in California is up more than 150 percent from 2009.

MOVING FORWARD

As renewable energy leaders nationally, California and Arizona, on the surface, would seem to each have strong potential for leveraging this leadership for water conservation as well.

At the very least, localities and states must pursue accurate and consistent monitoring of water supplies with a focus on connecting groundwater and surface water supplies. Without accurate data on water supplies, experts cannot accurately plan for the future. Local and state officials need to work closely with utilities to ensure that they are not only complying with all regulations but that they are also properly educated on how to develop accurate reports and plans to conserve water. The federal Department of Energy could represent a useful partner for sharing data-driven strategies and best practices.

[27] Dave Hawkins, Massive wind farm near Kingman changes ownership, *Bullhead City* (AZ) *Bee*, May 29, 2015.
[28] Dale Ross, Mayor: Why my Texas town ditched fossil fuel, *Time*, March 27, 2015.

Since a large percentage of the water supply in the West supports the agriculture industry and energy generated from fossil fuels, the incentives for these industries need to be examined. Important gains have been made regarding state policies for utilities' use of renewable energy. Present policies require California utilities to produce 33 percent of the energy in their portfolio with renewables by 2020. Arizona is seeking 15 percent by 2025. Progress is still needed in the agriculture industry. Officials need to evaluate incentives for farming and correlate that with drought-sensitive areas of the country to ensure that financial dependency is not a barrier to exploring more drought-friendly crops.

While mini-hydro power units may be an interesting, newer option for existing water structures, utilities must recognize that traditional hydroelectric power will not always represent an effective option in chronic drought conditions. The utilities' investments in fossil fuel power plants that require large quantities of water needs to be reallocated to renewable energy and state and federal policies should provide incentives and technical support to help move this initiative forward.

ABOUT THE AUTHOR

Kristen Nye Larson has more than 15 years of experience in communications and public affairs roles, and writes for EnergyTrends.org.

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